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AUTOMOTIVE DIESEL MAINTENANCE 2. UNIT VIII, AUTOMATIC TRANSMISSIONS--ALLISON TORQUMATIC SERIES 5960, 6060, AND 8860 (PART II).

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THIS MODULE OF A 25-MODULE COURSE IS DESIGNED TO DEVELOP AN UNDERSTANDING OF THE OPERATION AND MAINTENANCE OF SPECIFIC MODELS OF AUTOMATIC TRANSMISSIONS USED ON DIESEL POWERED VEHICLES. TOPICS ARE (1) GENERAL DESCRIPTION, (2) OPTIONAL EQUIPMENT, (3) TRANSMISSION POWER FLOW (SPLITTER SECTION), (4) TRANSMISSION POWER FLOW (RANGE SECTION), (5) INSPECTION AND MAINTENANCE, AND (6) TROUBLESHOOTING THE TRANSMISSION. THE MODULE CONSISTS OF A SELF-INSTRUCTIONAL PROGRAMED TRAINING FILM "LEARNING ABOUT THE ALLISON TORQUMATIC HYDRAULIC SYSTEM (PART I)" AND OTHER MATERIALS. SEE VT 005 685 FOR FURTHER INFORMATION. MODULES IN THIS SERIES ARE AVAILABLE AS VT 005 685 - VT 005 709. MODULES FOR "AUTOMOTIVE DIESEL MAINTENANCE 1" ARE AVAILABLE AS VT 005 655 - VT 005 684. THE 2-YEAR PROGRAM OUTLINE FOR "AUTOMOTIVE DIESEL MAINTENANCE 1 AND 2" IS AVAILABLE AS VT 006 006. THE TEXT MATERIAL, TRANSPARENCIES, PROGRAMED TRAINING FILM, AND THE ELECTRONIC TUTOR MAY BE RENTED (FOR $1.75 PER WEEK) OR PURCHASED FROM THE HUMAN ENGINEERING INSTITUTE, HEADQUARTERS AND DEVELOPMENT CENTER, 2341 CARNEGIE AVENUE, CLEVELAND, OHIO 44115. (HC)

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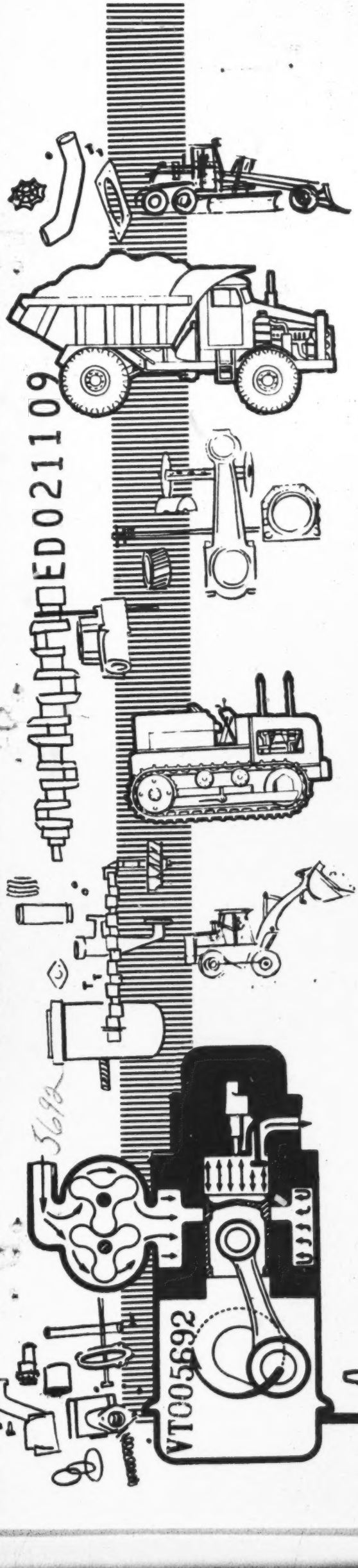

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STUDY AND READING MATERIALS

AUTOMOTIVE DIESEL MAINTENANCE 2

AUTOMATIC TRANSMISSIONS - ALLISON TORQMATIC SERIES 5960, 6060 & 8860 (PART II)

UNIT VIII

SECTION A	GENERAL DESCRIPTION
SECTION B	OPTIONAL EQUIPMENT
SECTION C	TRANSMISSION POWER FLOW (SPLITTER SECTION)
SECTION D	TRANSMISSION POWER FLOW (RANGE SECTION)
SECTION E	INSPECTION AND MAINTENANCE
SECTION F	TROUBLESHOOTING THE TRANSMISSION

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HUMAN ENGINEERING INSTITUTE

This unit describes in detail the functions of the transmission components in the CLBT-5960 series, which is similar in operation and structure to the 6000 and 8000 series. For information concerning a certain model transmission, refer to the appropriate maintenance manual.

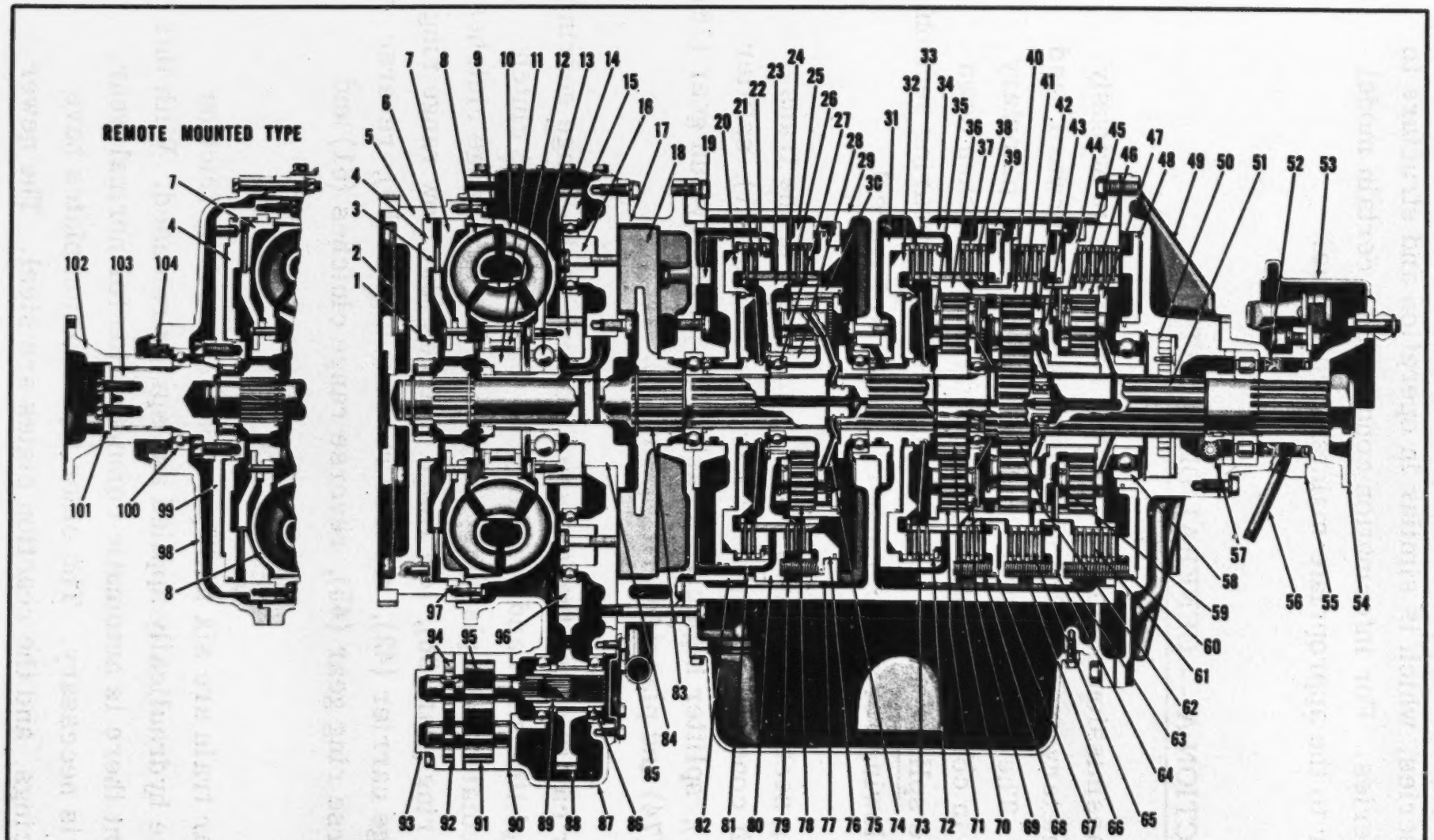
SECTION A -- GENERAL DESCRIPTION

The 5960 series transmission combines a torque converter (previously discussed) with planetary gearing that provides six speeds forward, and one reverse speed. The transmission gearing is a compound planetary gear train which is in constant mesh. The gearing can be broken down into two groups, the splitter gearing section and the range gearing section. NOTE: For the following reference numbers, refer to Figure 1.

The splitter gearing section is located in the front cavity of the transmission housing. It consists of a splitter low clutch drum (81), splitter low clutch pack (21), splitter high clutch pack (26), planetary sun gear (28), planetary carrier (74) and planetary ring gear (30).

Located in the rear cavity of the transmission housing is the range gearing. It consists of the splitter shaft and low sun gear (62), high range clutch drum (31), intermediate range planetary (69), intermediate range clutches (38), intermediate ring gear (36), low range clutches (65), low range ring gear (40), low range carrier (42), reverse range sun gear (59), reverse carrier (47), reverse ring gear (45), reverse range clutches (61) and output shaft (51).

Controlling the gear train are six multiple-disc, oil cooled, friction clutches. They are hydraulically applied and spring released. With this type of arrangement there is automatic compensation for normal wear, and no adjustment is necessary. The older type friction plates have sintered bronze facings, and the reaction plates are steel. The newer type friction plates are bonded resin graphite.



1-Piston Seal Ring
2-Flex Plate Assembly
3-Lockup Clutch Plate
4-Lockup Clutch Piston
5-Flywheel
6-Piston Seal Ring
7-Lockup Clutch Back Plate
8-Turbine
9-Stator Assembly
10-Converter Pump
11-Stator Roller Race
12-Stator Roller
13-Converter Pump Hub Bearing
14-Accessory Input Drive Gear
15-P.T.O. Gear
16-Gear Spindle
17-Brake Housing
18-Brake Rotor
19-Pitot Tube
20-Splitter Low Piston
21-Splitter Low Clutch Pack
22-Splitter Low Clutch Back Plate
23-Splitter Clutch Hub
24-Splitter Planetary Pinion Pin
25-Splitter High Clutch Anchor
26-Splitter High Clutch Pack
27-Bearing
28-Splitter Planetary Sun Gear
29-Transmission Housing
30-Splitter Planetary Ring Gear
31-High Range Clutch Drum
32-High Range Piston
33-Crush Wire
34-Intermediate Range Clutch Anchor
35-Inter. Range Planetary Pinion Pin
36-Intermediate Range Ring Gear
37-Intermediate Range Clutch Anchor
38-Intermediate Range Clutch Pack
39-Intermediate Range Piston Housing
40-Low Range Ring Gear

Fig. 1 Cutaway view of CLBT-5960 transmission

Key to Figure 1 (cont'd.)

41-Low Range Planetary Pinion
42-Low Range Planetary Carrier
43-Low Range Planetary Pinion Pin
44-Reverse Range Planetary Pinion Pin
45-Reverse Range Ring Gear
46-Reverse Range Planetary Pinion
47-Reverse Range Planetary Carrier
48-Reverse Range Piston
49-Rear Cover
50-Output Oil Pump Ass'y
51-Output Shaft
52-Oil Seal
53-Parking Brake Drum
54-Output Flange
55-Output Bearing Retainer
56-Oil Drain Nipple
57-Speedometer Drive Ass'y
58-Output Pilot Bearing
59-Reverse Range Sun Gear
60-Reverse Range Piston Return Spring
61-Reverse Range Clutch Pack
62-Splitter Shaft & Low Sun
63-Low Range Piston Housing
64-Low Range Piston
65-Low Range Clutch Pack
66-Low Rge. Piston Return Spring
67-Intermediate Range Piston
68-Int. Rge. Piston Return Spring
69-Int. Rge. Planetary Carrier Ass'y
70-Int. Range Sun Gear
71-Int. Rge. Planetary Pinion
72-High Range Clutch Back Plate
73-High Range Clutch Pack
74-Splitter Planetary Carrier Ass'y
75-Oil Pan
76-Splitter High Piston
77-Splitter High Piston Housing
78-Splitter High Planetary
79-Splitter High Piston Return Spring
80-Splitter High Clutch Back Plate
81-Splitter Low Clutch Drum Ass'y
82-Spacer
83-Turbine Shaft
84-Converter Ground Sleeve
85-Scavenge Pump Discharge Tube
86-Pump Drive Gear Hub
87-Converter Housing
88-Pump Drive
89-Pump Drive Gear Coupling
90-Input Oil Pump Body
91-Input Oil Pump Driven Gear
92-Scavenge Oil Pump Driven Gear
93-Scavenge Oil Pump Body
94-Scavenge Oil Pump Drive Gear
95-Input Oil Pump Drive Gear
96-Idler Gear
97-Lockup Clutch Back Plate Key
98-Front Cover
99-Piston Housing
100-Cover Bearing
101-Retaining Washer
102-Input Flange
103-Input Shaft
104-Cover Seal

As mentioned previously, the 5960 and the 6000 and 8000 series transmissions can be shifted under full power. It is possible to upshift or downshift at full throttle regardless of the load. However, a downshift should not be made if the vehicle speed exceeds the maximum speed attainable in the next lower range. A downshift under this condition will overspeed the engine and cause serious damage. The vehicle must be brought to a complete stop before shifting into reverse.

Another precaution is required before starting the unit: the transmission must be shifted into NEUTRAL. Most vehicles manufactured today are equipped with a neutral-starting device which will not permit starting the unit in any position but neutral. Also, shift the transmission into neutral when the unit is parked and the engine is idling for any period of time.

SECTION B -- OPTIONAL EQUIPMENT

In Figure 1, the optional remote mounting feature is shown. If the transmission is direct mounted, the torque converter housing is bolted directly to the engine flywheel housing. For a remote mounting, the converter input shaft (103) is bolted to the piston housing (99) and the converter front cover (98) encloses the front of the converter. Engine torque is received through the companion flange (102) which is splined to the converter input shaft.

The Torqmatic Brake is an integral part of the transmission and provides constant braking power on downhill hauls. The brake consists of three major components: the rotor (18) which is splined to the turbine shaft (83), the stator vanes cast into the brake housing (17), which also encloses the rotor; and the brake control valve, which is mounted to the left side of the brake housing (17). The valve provides various degrees of braking power. A torque limiting valve, built into the valve housing, protects the transmission from absorbing brake horsepower in excess of 1200 ft. lbs. The brake uses the same oil as the transmission. Therefore, extra charging pumps are not required.

The lock-up clutch assembly is an integral part of the transmission and consists of a piston (4), clutch plate (3), backing plate (7) and a gear which is riveted to the turbine (8). In remote mounted transmissions, the lock-up assembly is installed in the converter pump cover and consists of the same parts as in a direct mounted transmission.

Although shifting in 5960 series transmissions is manually controlled, the lock-up shift is controlled hydraulically. It occurs automatically in all ranges, including neutral. Disengagement of lock-up for 5960 transmission occurs at 1570 rpm turbine shaft speed.

SECTION C -- TRANSMISSION POWER FLOW (SPLITTER SECTION)

NOTE: All numbers in the following paragraphs refer to Figure 1 unless otherwise specified.

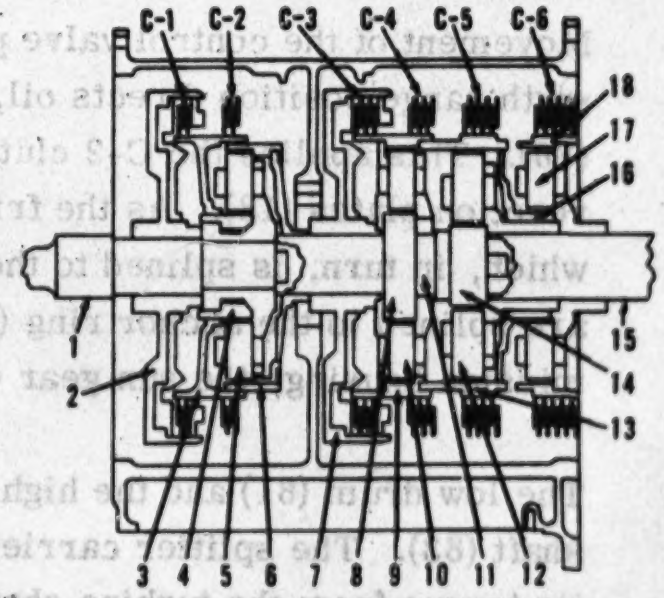
In the discussion to follow, keep in mind that the turbine shaft (83) supplies the input torque to the splitter section. Input torque for the range gearing is supplied by the splitter ring gear (30). Output torque leaves the planetary gearing through either the low or reverse range carriers (42 or 47), which are splined to the output shaft (51).

Figure 2 illustrates schematically, the entire gear train of the transmission. To clarify the power flow discussion, the various clutches will be labeled in the following manner: splitter low (C-1), splitter high (C-2), high (C-3), intermediate (C-4), low (C-5) and reverse (C-6).

When this transmission is in neutral, the C-1 clutch (splitter low) is engaged. This prevents the engagement of two clutches at the same time when a shift is made. Refer to the paragraphs below, under "splitter low" for neutral power flow.

The splitter section contains two clutches, splitter low (C-1) and splitter high (C-2). The term direct drive can be interchanged for splitter low, and overdrive can be used in place of splitter high.

Movement of the control valve plunger into either neutral, first, third, fifth or reverse range directs



1-Turbine Shaft
2-Splitter Low Drum
3-Hub
4-Splitter Sun Gear
5-Splitter Planetary
6-Splitter Ring Gear
7-High Range Drum
8-Intermediate Sun Gear
9-High-Intermediate Ring Gear
10-Intermediate Planetary
11-Splitter Shaft
12-Low Planetary
13-Low Ring Gear
14-Low Sun Gear
15-Output Shaft
16-Reverse Sun Gear
17-Reverse Planetary
18-Reverse Ring Gear

Fig. 2 Transmission gearing schematic

oil under pressure to the splitter low piston (20). This applies the C-1 clutch (21), which consists of two friction and one reaction plates.

The splitter low clutch drum (81) and the splitter carrier (74) are splined to the turbine shaft (83). The friction plates are splined to the hub (23) which in turn, is splined to the splitter sun gear (28). The reaction plates are splined to the clutch drum (81). When C-1 clutch is applied, the clutch drum (81), hub (23), sun gear (28) and splitter carrier (74) are locked together.

The clutch drum (81) and carrier (74) are splined to the turbine shaft (83). The clutch drum (81) is the input member and receives its torque from the turbine shaft (83). As the clutch drum (81), hub (23), sun gear (28) and carrier (74) are all locked together, the turbine shaft (83) and the entire splitter gearing rotate as a mass.

Movement of the control valve plunger into either the second, fourth or sixth range position directs oil, under pressure, to the splitter high piston (76). This applies the C-2 clutch, consisting of three friction and three reaction plates (18). As the friction plates are splined to the hub (23) which, in turn, is splined to the sun gear (28), and the reaction plates are splined to the anchor ring (25) which is firmly keyed to the transmission housing, the sun gear (28) becomes the held member.

The low drum (81) and the high carrier (74) are splined to the turbine shaft (83). The splitter carrier (74) is the input member and receives its torque from the turbine shaft (83). As the sun gear (28) and hub (23) are held, the planet pinions (78) drive the ring gear (30) in the same direction, providing the overdrive reduction of .671 : 1.

SECTION D -- TRANSMISSION POWER FLOW (RANGE SECTION)

NOTE: All numbers in the following paragraphs refer to Figure 1 unless otherwise specified.

GENERAL -- To obtain the desired speed range, one of the range clutches (C-3, 4, 5 or 6) is engaged (see Figure 2). The proper clutches are automatically engaged by movement of the control valve plunger. In order to obtain first, third, fifth or reverse ranges, the appropriate range clutch (C-3, 4, 5 or 6) is combined with splitter low clutch (C-1) of the splitter section. Second, fourth and sixth ranges are obtained by combining the appropriate range clutch (C-3, 4 or 5) with the splitter high clutch (C-2) of the splitter section. Table I illustrates clutch application and gear ratio charts for 5960 transmission.

FIRST AND SECOND RANGE -- Movement of the control valve plunger into the first (1st) or second (2nd) position results in the same power through the planetary gearing. However, in the splitter section, the splitter low clutch (C-1) is engaged for the first range and the splitter

Shift Tower Position and Gear Range	Splitter Section		Planetary Gearing Section				Main Pressure Schedule		Gear Ratio	Lock-up Clutch
	Low C-1	High C-2	High C-3	Int. C-4	Low C-5	Rev. C-6	Min.	Max.		
6th		X	X				130	155	.67:1	X
5th	X		X				130	155	1.00:1	X
4th		X		X			130	155	1.35:1	X
3rd	X			X			130	155	2.01:1	X
2nd		X			X		130	155	2.68:1	X
1st	X				X		210	235	4.00:1	X
N	X						130	155		X
R	X					X	210	235	5.12:1	X

Table I Clutch application table for the 5960 transmission

high clutch (C-2) is engaged for second range. This provides a 4.00 : 1 ratio for first range and a 2.68 : 1 ratio for the second range.

When the control valve plunger is shifted to the first or second range, pressurized oil is directed to the low range piston (64). This applies the C-5 clutch, which consists of four friction plates and reaction plates (65). As the friction plates are splined to the low range ring gear (40) and the reaction plates are splined to the anchor ring which is firmly keyed to the transmission housing, the low range ring gear (40) is the held member.

The low range sun gear (62) is the driving member and receives torque from the splitter ring gear (30) and the turbine shaft (83). As the ring gear (40) is held and the sun gear is driving, the low planet pinions (41) are forced to walk around the ring gear, taking the carrier with them. Output torque leaves through the carrier (42), which is splined to the output shaft (51). See Figures 3 and 4.

THIRD AND FOURTH RANGE -- Movement of the control valve plunger, into the third or fourth position results in the same power through the planetary gearing. However, in the splitter section, the splitter low clutch

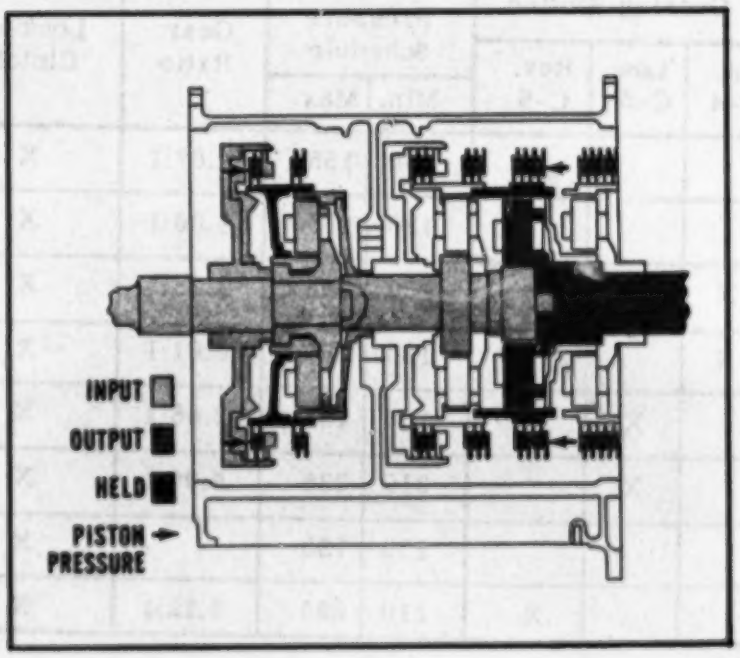


Fig. 3 First range power flow

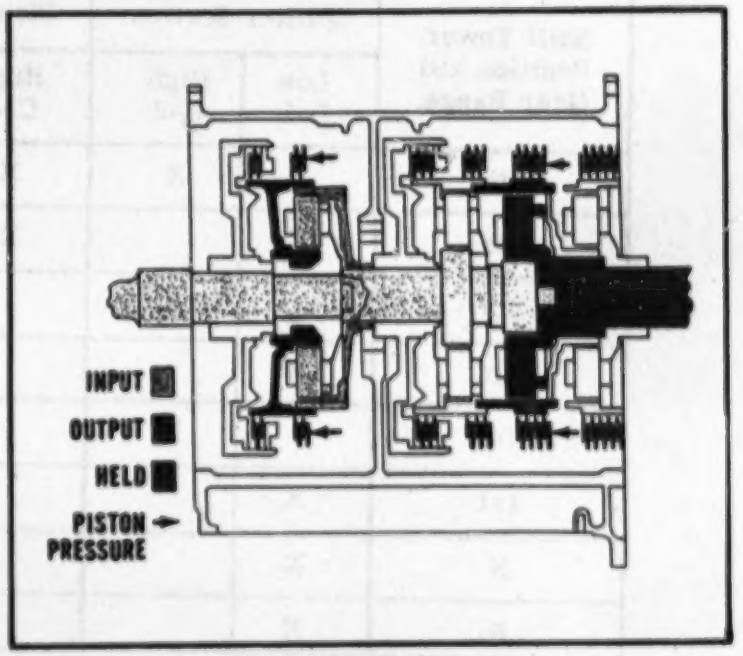


Fig. 4 Second range power flow

(C-1) is engaged for the fourth range. This provides a 2.01 ratio for the third range and a 1.35 : 1 ratio for fourth range.

When the control valve plunger is shifted to the third or fourth range, pressurized oil is directed to the intermediate range piston (67). This applies the C-4 clutch, which consists of three friction and reaction plates (38). As the friction plates are splined to the intermediate range ring gear (36) and the reaction plates are splined to the anchor ring, which, in turn, is firmly keyed to the transmission housing, the intermediate ring gear (36) is held stationary.

The intermediate sun gear (70) is splined to the splitter shaft (62) and the low range sun gear is integral with the shaft. The intermediate carrier (69) is connected to the low range ring gear (40) and the low range carrier (42) is splined to the output shaft (51).

The driving member is the intermediate sun gear (70), which receives its torque from the splitter ring gear (30) and turbine shaft (83). Since the ring gear (36) is held and the sun gear (70) is driving, the intermediate planet pinions (71) are forced to walk around the inside of the ring gear (36), forcing the intermediate carrier to rotate in the same direction as the sun gear (70). Since the intermediate carrier is connected to the low range ring gear (40), the carrier and the ring gear rotate together. The low range sun gear (62) and the low range ring gear (40) are rotating in the same direction, but at different speeds. As a result, the output torque leaves through the low range planetary carrier (42), which is splined to the output shaft (51). See Figures 5 and 6.

FIFTH AND SIXTH RANGE -- Movement of the control valve plunger into the fifth and sixth positions results in the same power through the planetary gearing. However, in the splitter section, the splitter low clutch (C-1) is engaged for the fifth range and the splitter high clutch (C-2) is engaged for the sixth range. This provides a 1.00 : 1 ratio for fifth range and a .67 : 1 ratio for sixth range.

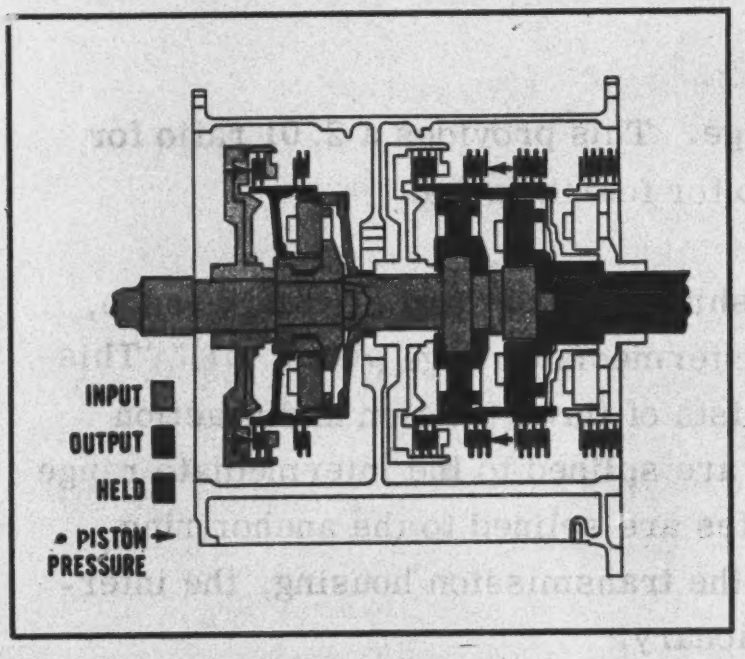


Fig. 5 Third range power flow

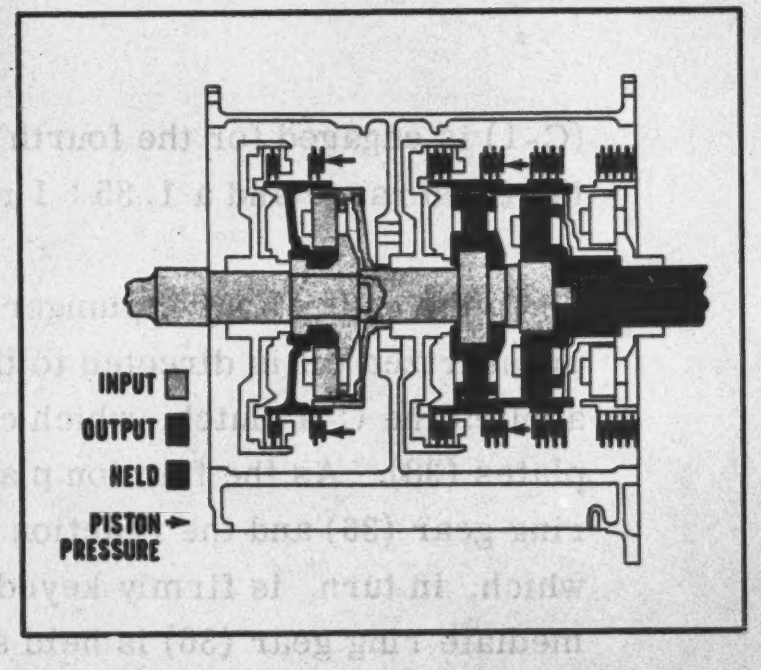


Fig. 6 Fourth range power flow

When the control valve plunger is shifted to the fifth or sixth range, pressurized oil is directed to the high range piston (32). This applies to the C-3 clutch, which consists of three friction and two reaction plates (73). As the friction plates are splined to the intermediate range ring gear (36) and the reaction plates are splined to the high range clutch drum (31), the clutch drum and the intermediate range ring gear are locked together.

The following parts are connected together: splitter ring gear (30), intermediate sun gear (70), and low sun gear (62). As the shaft revolves, it drives the entire range gearing and output shaft (51) in the same direction and speed. See Figures 7 and 8.

REVERSE RANGE -- Movement of the control valve plunger to reverse position engages the splitter low clutch (21) and directs pressurized oil to the reverse range piston (48). This applies the C-6 clutch, which consists of five friction plates and five reaction plates (61). As the friction plates are splined to the anchor ring which, in turn, is keyed to the transmission housing, the reverse ring gear is the locked stationary member.

The reverse range sun gear (59) is splined to the low range ring gear (40) and the reverse carrier (47) and low range carrier (42) are splined to the

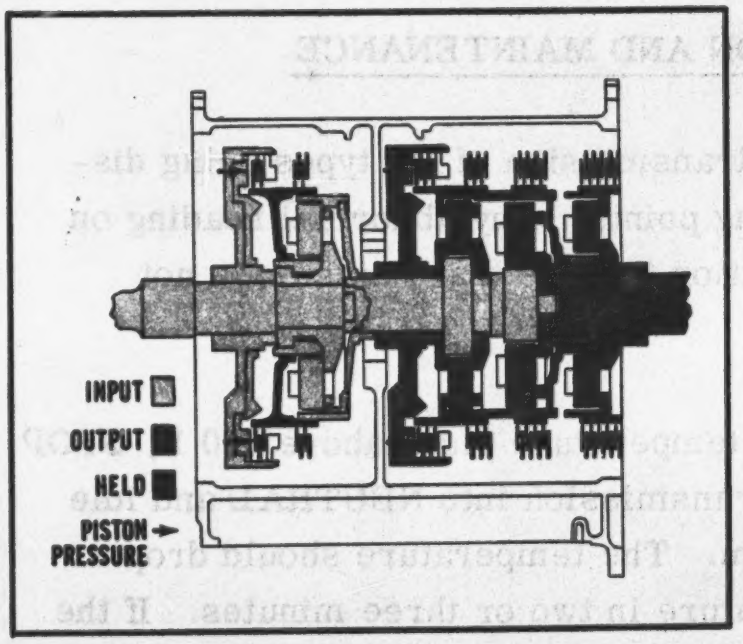


Fig. 7 Fifth range power flow

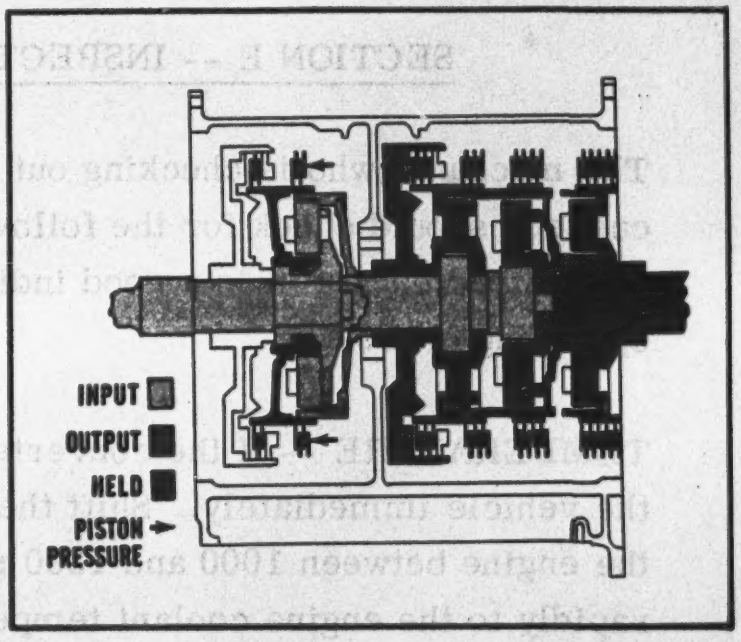


Fig. 8 Sixth range power flow

output shaft (51), creating a compound planetary between the low and reverse planetaries.

Input member is the low range sun gear (62) which receives its torque from the splitter ring gear (30) and turbine shaft (83). The low planet pinions (41) revolve about their pins in the opposite direction of the sun gear (62) and they, in turn, drive the low range ring gear (40) in the same direction. As the low range ring gear (40) is splined to the reverse sun gear (59), the sun gear rotates in the same direction as the ring gear. With the low ring gear (40) and reverse sun gear (59) driving in the same direction and the reverse ring gear held, the reverse pinions (46) revolve about their pins in the opposite direction. This drives the carrier (47), which is splined to the output shaft (51), in the same direction providing the reverse reduction of 5.12 : 1. See Figure 9.

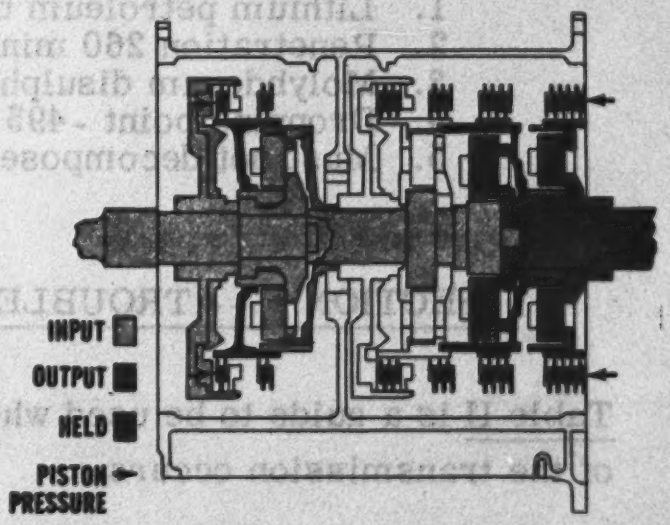


Fig. 9 Reverse range power flow

SECTION E -- INSPECTION AND MAINTENANCE

The mechanic who is checking out a transmission of the types being discussed, should check for the following points. Any abnormal reading on the instrument panel is a good indication that the transmission is not operating correctly.

TEMPERATURE -- If the converter temperature rises above 250 F, STOP the vehicle immediately. Shift the transmission into NEUTRAL and idle the engine between 1000 and 1300 rpm. The temperature should drop rapidly to the engine coolant temperature in two or three minutes. If the temperature does not drop, trouble is indicated and the cause should be determined before further operation of the vehicle.

CLUTCH PRESSURE -- Clutch pressure can be observed by looking at the transmission clutch pressure gage on the instrument panel. On newer model vehicles (since 9/1/66) pressures must be maintained between 170 and 210 psi. On models built prior to this date, pressure in first and reverse ranges should be maintained between 185 and 235 psi. They should be between 115 and 155 psi in neutral, second and third, fourth, fifth and sixth ranges.

GREASE SPECIFICATIONS -- The grease used to coat the output shaft splines must meet the following specifications:

1. Lithium petroleum base grease
2. Penetration 260 minimum
3. Molybdenum disulphide (20% minimum by weight)
4. Dropping point -495 F
5. Must not decompose at 400 F

SECTION F -- TROUBLESHOOTING THE TRANSMISSION

Table II is a guide to be used when a malfunction or irregular operation of the transmission occurs.

Table II Troubleshooting the transmission

TROUBLE	CAUSE	CHECK AND/OR REMEDY
Low converter OUT pressure	Low oil level	Bring oil level to full mark.
	Oil line leakage	Check lines for oil leaks.
	Plugged oil strainer	Remove and clean strainer.
	Defective oil pump	Check pump and rebuild, if necessary.
	High oil temperature	See High Oil Temperature below
	Foaming oil	See Loss of Power below
	Converter pressure regulator valve stuck open	Inspect valve for dirt or damaged parts
High oil temperature	Low oil level	Bring oil level to full mark
	High oil level	Drain oil to full mark
	Low coolant level in cooling system	Bring coolant level to full mark
	Clogged or dirty oil cooler	Replace cooler
	Stator locked	Rebuild converter
	Stator installed backwards	Check for lack of power at converter stall or disassemble converter and check stator
	Stator installed without rollers (low stall speed)	Disassemble converter and install rollers
	Operating too slow in gear selected	Downshift at a higher speed
High engine speed at converter stall	Low oil level	Bring oil level to full mark
	Low converter out pressure	See above
	High oil temperature	See above
	Slipping clutch	Overhaul transmission
Low engine speed at converter stall	Low engine output torque	Tune engine and check output torque
	Converter element interference	Check for noise at stall, rebuild converter, if necessary
	Stator installed backwards	Check for lack of power at converter stall or disassemble converter and check stator
	Stator installed without rollers	Disassemble converter and install rollers

Table II Troubleshooting the transmission (cont'd)

TROUBLE	CAUSE	CHECK AND/OR REMEDY
Loss of power	Stator installed backwards	Check for loss of power at stall or disassemble converter and check stator
	Stator installed without rollers	Disassemble converter and install rollers
	Low converter charging pressure	Check for lack of power at stall
	Low engine speed at converter stall	See above
	Clutch plates slipping	Check for low clutch pressure Check for worn piston seals
	Range control valve inoperative	See below
	Low clutch pressure	See below
	Foaming oil	Check oil level Check for proper oil Check input pressure pump Check for water in oil
No power transmitted in any range	Range Control valve inoperative	Check shift linkage adjustment Check valve parts for wear
Low clutch pressure	Low oil level	Bring oil level to full mark
	Leaks in lube system	Check for oil leaks in external pressure lines and air leaks on suction side of pump
	Pressure regulator valve failed	Rebuild pressure regulator valve assembly
	Worn input oil pump	Rebuild pump
	Plugged clutch piston cavity inlet line or oil strainer	Drain oil and clean strainer Disassemble transmission enough to check for plugged inlet line
No power transmitted in one range	Low clutch pressure in one range only	Check for worn piston seals Check for broken backing plate
	Range control valve inoperative	See above
Slow clutch engagement	Foaming oil	See above
	Low clutch pressure	See above
	Worn piston seals	Replace piston seals
Transmission locked in all ranges	Transmission failure	Rebuild transmission
Unit drives in first or second range, creeps forward in neutral but stalls when shifted into any other range	Low range clutch failure	Rebuild transmission

Table II Troubleshooting the transmission (cont'd)

TROUBLE	CAUSE	CHECK AND/OR REMEDY
Unit drives in third or fourth range, creeps forward in neutral but stalls when shifted into any other range	Intermediate range clutch failure	Rebuild transmission
Unit drives in fifth or sixth range, creeps forward in neutral but stalls when shifted into any other range	High range clutch failure	Rebuild transmission
Unit drives in reverse range, creeps backward in neutral but stalls when shifted into any other range	Reverse range clutch failure	Rebuild transmission
Unit drives in low, erratic shifting from one range to another but stalls when shifting from neutral to low or reverse	Lock-up clutch failure	Rebuild transmission
Unit drives in reverse, first, third and fifth range but stalls when shifted in other ranges	Splitter-low clutch failure	Rebuild transmission
Unit drives in second, fourth, and sixth range but stalls when shifted into other ranges	Splitter-high clutch failure	Rebuild transmission
Failure to go into lock-up	Low pitot pressure	Check oil level, clean pitot feed orifice and pitot tube
	Malfunction of lockup shift valve	Check and repair valve
	Malfunction of flow valve	Check and repair valve
Torqmatic brake fills slowly	Secondary converter pressure regulator valve stuck open	Repair regulator valve
	Clogged oil cooler	Replace oil cooler element
Torqmatic brake fails to operate	Torque limiter valve stuck open	Check and repair valve
	Torque limiter valve spring weak	Rebuild valve and replace spring
Low pitot pressure	Insufficient lube oil	Bring oil level to full mark
	Clogged pitot feed orifice	Disassemble converter and clean orifice
	Clogged pitot tube	Disassemble converter and clean pitot tube

1

AM 2-8D
8/21/67

LEARNING ABOUT THE ALLISON TORQMATIC HYDRAULIC SYSTEM -- (PART I)

Human Engineering Institute

Minn. State Dept. of Ed.
Vocational Education

Press A 2

Check to see that timer is OFF.

2

This film supplements the class text units which describe the operation of the Allison Torqmatic Transmission hydraulic system. The torque converter part of the transmission will not be covered in this film. The film lesson on the torque converter is AM 2-5D.

NOTE: A large portion of this film refers to Figure 1 in AM 2-9. Have this fold-out color schematic available before using this film.

1-2

Press A 3

3

The Allison transmission incorporates a combination oil pressure and scavenge pump which is located at the lower front of the transmission. It is a conventional gear-type pump, having two separate pairs of gears with a common housing. This pump always turns at the same rpm as the engine. For this to be possible, the pump would have to be driven by the _____.

A. transmission output shaft 4
B. converter turbine 4
C. Neither A or B is correct 5

1-3

4

If you chose transmission output shaft or converter turbine, you are incorrect. The only mechanism in the transmission that turns the same rpm as the engine output shaft is the converter pump and shaft.

Press A 5

1-4

5

Correct. The input charging pump has to be driven by the converter pump so oil can be supplied from the sump to the transmission hydraulic system when the engine is started.

A simple spur gear train extends from the pump housing to the converter pump element. The larger set of gears in the pump provides oil to the hydraulic circuit. The smaller pair of gears provides for the scavenge pump.

1-5

Press A 6

6

The scavenge pump draws excess oil from the converter housing, in which the converter and pump gear train operate, and returns it to the sump. The input pump supplies oil to the hydraulic circuit at all times while the engine is running.

OIL FILTERS -- The oil passes through two disposable cartridge-type filter elements in parallel. The filters are arranged for full-flow operation, which means that all the oil flowing in the circuit must pass through them.

1-6

Press A 7

7

The input charging pump and scavenge pump are _____.

A. two pumps of the same size in one housing 8
B. two different sized pumps in separate housings 8
C. Neither A or B is correct 9

1-7

8

No. There are two pumps of different sizes (gears) in the same housing. One, the larger of the two, supplies oil to the hydraulic circuit; the smaller one provides for scavenging of the excess oil in the converter housing.

Press A 9

1-8

9

Correct. The two pumps (input and scavenge) are of different sizes, but are enclosed in one housing. The larger pump provides input oil to the entire unit while the smaller pump is used to scavenge excess oil from the converter housing.

SIGNAL SWITCH -- A signal switch, located in the filter base assembly, warns the vehicle operator that the oil filters are becoming clogged with debris. This switch is activated by differential oil pressure in the filter base.

1-9

Press A 10

10

When oil pressure flowing into the filter elements exceeds the pressure coming out by 15 psi, electrical contact is made to a signaling device located in the vehicle operator's compartment. When the filter elements are completely clogged, and the differential oil pressure in the filter base is 20 psi, a filter bypass valve opens and allows the oil to bypass the filter elements.

Press A 11

1-10

11

The oil filter signal switch in the operator's compartment activates when _____.

A. unfiltered oil is traveling through the system 12

B. oil pressure leaving the filters exceeds that 13 entering the filters

C. Neither A or B is correct. 14

1-11

12

No. Unfiltered oil flowing through the system means the bypass valve has opened and no oil at all is being filtered. Please try this question again. Press A 11

1-12

13

No. Oil under pressure entering the filters always is slightly higher than that leaving the filters, due to the friction and obstruction characteristics of the filter.

Try this question again. Press A 11

1-13

14

Correct. The signal activates when oil under pressure entering the filters exceeds the outcoming pressure by 15 psi. Unfiltered oil flowing through the system would mean the pressure had exceeded _____ psi.

A. 25 XX
B. 20 15
C. 30 XX

(Only the correct answer will move the film.)

1-14

15

MAIN PRESSURE VALVE -- Main pressure in the hydraulic circuit is regulated by the movement of a spool type valve, located in the control valve body. See Figure 1 in AM 2-9. Its movement opens or closes ports through which the oil may flow. The degree of such opening or closing determines the volume of flow and thereby the pressures. Forces act upon the valve from either end. Function and movement are fully automatic. The pressure is regulated to the required value for various requirements of pressure and flow.

1-15

Press A 24

24

LOCKUP SHIFT VALVE -- Flow of oil to and from the lockup clutch piston cavity is controlled by the lockup clutch shift valve, see Figure 1 in AM 2-9. The shift valve is a spool-type valve. Movement of the valve in its bore opens or closes ports which determine whether the lockup clutch is engaged or disengaged. This valve is located in the lockup valve body.

Press A 25

1-24

25

Working in conjunction with the lockup shift valve is the spool-type flow valve, located in the lockup valve body. Its function is to override the lockup shift valve so as to disengage the lockup clutch when shifts are made, up or down. The movement of the valve exhausts lockup clutch apply pressure to sump.

It is necessary to disengage the lockup clutch when shifting because _____.

A. there are varying degrees of torque required in the different ranges 27

B. lockup clutch pressure must be released to move the manual control valve 26

C. oil in the lockup circuit is required for the planetary clutch pistons 26

1-25

26

No. The lockup clutch must be released when shifting occurs, because of the varying degrees of torque that are required when going from one range to another.

Press A 27

1-26

27

Correct. The lockup clutch is activated only when the turbine and pump almost equal each other in rpm. If the clutch were continually activated, the converter would serve as a fluid coupling, defeating the purpose of the converter.

Much has been said about the manual selector valve but let's review what the purpose of this valve is. It:

1. Permits shifting of the transmission;
2. Directs oil pressure to the neutral signal valve trimmer plug in the neutral position.

Press A 29 X(c)- 28

2-27

28

OK.
Because of varying degrees of torque required when shifting or encountering a load, the lockup clutch is deactivated.

You have missed one or more of the questions in this sequence of material. Before going further, review the last few frames

Press A 3

1-28

29

INTERMEDIATE RANGE CLUTCH TRIMMER VALVE --This valve is located in the control valve body. See Figure 1 in AM 2-9. The function of this valve has to do only with the smooth application of the intermediate range clutch. It provides the initial reduction of pressure to that clutch, followed by a rise in pressure to equal the main pressure. This valve operates the same as the neutral signal trimmer valve, except that there is no oil pressure present at the opposite end.

NOTE: Read the above information again before pressing A. 30

2-29

30

In the last frame we said the intermediate range clutch trimmer valve has to do with smooth application of the intermediate range clutch. In your opinion, which of the following statements best describes the function of this valve? It is _____.

A. a safety device that acts as a sump for this hydraulic circuit 31

B. a device that permanently retains a portion of the hydraulic pressure going to the intermediate range clutch 31

C. a device that prevents initial full main pressure from activating the intermediate range clutch 32

2-30

31

No. This valve acts as a buffer in this hydraulic circuit. It prevents the initial full force of the main pressure from activating the intermediate clutch suddenly. The main pressure is applied eventually, but the "shock" is removed by this valve.

Press A 32

2-31

32

Correct. This valve prevents jerking of the vehicle when the intermediate ranges are selected by the operator.

In previous units we learned about the multi-bladed retarder mechanism located behind the converter. This device is controlled by a vertically mounted, spool type valve (Torqmatic Retarder Valve) connected by linkage with a hand lever or foot pedal controlled by the operator of the vehicle. See Figure 1 in AM 2-9.

The retarder is applied when the valve is pushed downward in the body and released in its upward position.

Press A 33

2-32

33

A spring located at the bottom end of the valve, assures a positive "OFF" position when the brake is released. Oil supply for the retarder comes from the flow out of the torque converter. The oil from the retarder is directed through the heat exchanger (oil cooler).

A torque limiter valve is incorporated in the retarder valve body. This is a spring loaded bypass valve which opens when pressure in the line carrying oil from the brake exceeds 50 psi, at which time the oil flows directly to the sump, bypassing the cooler.

Press A 34

2-33

34

The valve limits the amount of oil in the brake so it will absorb no more than 1200 pound feet of torque. This protects the transmission and power train from overloads during retarder operation.

If the torque limiter valve were set to open at a lower psi (lower than 50), there would be _____ braking action.

A. less 36
B. more 35
C. no change in 35

2-34

35

No. If the valve had a weaker spring, oil would be directed to sump at a lower pressure, reducing the effectiveness of the braking power.

Press A 36

2-35

36

Correct. The more oil under pressure directed into the retarder blades, the more resistance there is to turning.

FLUID VELOCITY (pitot) GOVERNOR -- The fluid velocity governor provides the pressure necessary to actuate the lockup shift valve to secure lockup of the torque converter. You will recall that we have said that lockup occurs when the turbine almost matches the speed of the pump in the converter. Let's see how this operates.

The fluid velocity governor consists of only two simple parts. One part is the collector ring. It is attached to and turns with the low splitter (direct drive) clutch drum which turns at turbine speed.

2-36

Press A 37

37

The other part of the fluid velocity governor is the pitot tube which is nothing more than a stationary tube bolted to the converter housing, with an open end, facing opposite the rotation of the governor collector ring.

OPERATION -- When the transmission is in operation, oil is supplied through an orifice to a point where it flows into the inner side of the collector ring, keeping it filled. Oil is retained in the collector ring by centrifugal force as the ring turns. The pitot tube, being immersed in and facing the moving oil, receives oil and directs it to the main pressure regulator valve and the lockup shift valve.

Press A 38

2-37

38

Pressure in the pitot line is proportional to the speed of the oil striking the open end of the pitot tube; hence the name "fluid velocity governor".

Before discussing more about the transmission hydraulic system, let's review what we have covered so far.

The Allison Transmission uses a combination oil pressure and scavenge pump which is driven through a gear arrangement. The driving member is the _____.

A. turbine 39
B. converter pump 40
C. stator 39

2-38

39

No. The combination oil and scavenge pump is driven by the converter impeller (pump) which is splined to the engine output shaft.

Press A 40

2-39

40

OK. Earlier we mentioned that the gears in one set in this pump were smaller than the other set, with the larger set being used for the _____ pump.

A. scavenge 41
B. input charging 42
C. I don't know 41

2-40

41

No. The input charging pump has the larger set of gears. The scavenge pump has the smaller set of gears. However, both are enclosed in the same housing.

Press A 42

2-41

42

OK.

The purpose of the scavenge pump is to _____

A. drain oil from the retarder compartment 43
B. drain excess oil from the converter housing 44
C. Neither A or B is correct. 43

2-42

43

No. The correct answer is that the scavenge pump drains the excess oil from the converter housing and returns it to sump.

Press A 44

2-43

44

OK. The scavenge pump drains the excess oil from the converter and returns it to sump.

Normally, oil pressure is higher on the inlet side of the filter assembly than on the outlet side. This is a _____ statement.

A. true 49
B. false 45

2-44

45

No. Oil pressure is higher on the inlet side because of the natural restriction that a filter will offer to oil flowing through it.

Press A 49

2-45

49

OK. We learned earlier that if the inlet pressure exceeds 15 psi, an electrical impulse activates a signal in the operator's cab warning him that the filters need replacing.

The lockup clutch must be disengaged when shifting occurs because _____

A. various degrees of torque are required in different ranges 51
B. there is no other way to release the clutches holding the planetary gears 50
C. Neither A or B is correct. 50

2-49

50

No. The lockup clutch has nothing to do with the planetary gears in the transmission. This clutch is concerned directly with the converter. When clutch pressure is applied, all parts in the converter turn as a unit. The correct answer is that various degrees of torque are required in the different ranges.

Press A 51

2-50

51

OK. If the converter components are locked together, it then serves as a fluid coupling and the torque requirements in the different ranges cannot be met.

The prime function of the intermediate range clutch transmission valve is to _____

A. temporarily reduce the main oil pressure going to the intermediate range clutch pack 53
B. assure that a constant oil pressure is present at the intermediate range clutch pack 52
C. Neither A or B is correct. 52

2-51

52

No. If constant oil pressure were applied to the intermediate range clutch pack, it would always be activated. The correct answer is that this valve temporarily reduces main pressure going to the clutch pack.

Press A 53

2-52

53

OK. Oil pressure is interrupted momentarily by this valve, to prevent grabbing of the clutch pack.

In your opinion, which of the following words best describes the pitot circuit?

A. governor 55
B. pump 54
C. clutch 54

2-53

54

No. The answer we want here is governor. As you recall, the pitot circuit is called the fluid velocity governor. Its purpose is to provide the pressure necessary to actuate the lockup shift valve.

Press A 55

2-54

55

OK. The pitot circuit provides the pressure necessary to actuate the lockup valve.

Converter Pressure Relief Valve -- Oil pressure to the converter is limited by the converter pressure relief valve. If pressure exceeds 80 psi (such as during cold starts), the valve will open and exhaust the excess oil to the sump. See Figure 1 in AM 2-9.

Press A 57 X(C)-56

3-55

56

Correct. Governor is the answer to the last question.

You have missed one or more of the questions in this sequence. Review this portion again, read carefully and take your time in answering the questions.

Press A 29

2-56

57

Converter Bypass Valve -- This valve is used only in the CLBT 5960 and 6060 series transmission. See Figure 1 in AM 2-9. It allows excessive oil pressures which are being directed to the torque converter to exhaust into the converter-out line. During high speed operations the converter does not require the amount of oil being directed to it. Therefore, when converter-in oil pressure exceeds converter-out pressure by 3 psi, the valve opens, allowing excessive converter-in oil to bypass the torque converter.

Read this frame again before pressing A. 58

3-57

58

Converter Pressure Regulator Valve -- Like the bypass valve mentioned earlier, this valve is used only on the CLBT 5960 and 6060 series transmission. It is located in the main transmission housing. It works against spring pressure and will exhaust to sump any oil in excess of 22.5 psi coming from the torque converter through the oil cooler. Therefore converter oil pressure is regulated by this valve and by any restrictions in the oil cooler and converter-out oil line.

Press A 59

3-58

59

Looking at Figure 1 in AM 2-9, the converter bypass valve will open _____.

A. during slow speeds of the vehicle 60
B. when the converter-in oil pressure exceeds converter-out pressure by 22 psi 61
C. when the converter does not require the amount of oil being directed to it 62

3-59

60

No. The converter bypass valve opens when the vehicle is traveling at high speeds and torque requirements are low. Try this question again.

Press A 59

3-60

61

No. You have the bypass valve confused with the pressure regulator valve. You are right on one point though, the bypass valve does open when the converter-in pressure exceeds converter-out pressure (by 3 psi). The correct answer is: when the converter does not require the amount of oil being directed to it.

Press A 62

3-61

62

OK. When the converter-in pressure exceeds converter-out pressure by 3 psi, the bypass valve opens and directs the excess oil to the _____.

A. sump 63
B. converter-out circuit 65
C. converter-in circuit 64

(Look at Figure 1 in AM 2-9.)

3-62

63

No. Look at Figure 1 in AM 2-9. To exhaust the converter-in pressure to sump, the pressure would have to exceed 80 psi and would be directed through the pressure relief valve.

Try this question again. Press A 62

3-63

64

No. Look at Figure 1 in AM 2-9. If the converter-in pressure were greater than the converter-out pressure it would not be feasible to try to direct oil into the converter-in circuit.

Try this question again. 62 Press A

3-64

65

Correct. Should the pressure in the converter-in circuit exceed 80 psi, oil would be flowing through the converter pressure relief valve, as well as through the converter bypass valve.

Converter-In Check Valve -- This valve is used only in the CLBT 5960 and 6060 series transmission. See Figure 1 in AM 2-9. The valve is located in the transmission converter housing. The valve will not allow the converter-in oil pressure to drop lower than 20.5 psi.

3-65

Press A 66

66

Oil pressure on one side of the check valve, regulated at 22.5 psi by the converter pressure regulator valve, is opposed by converter-in oil pressure and by a 2 psi valve spring pressure on the other side. If converter-in oil pressure drops below 20.5 psi, oil from the oil cooler (regulated at 22.5 psi by the converter regulator valve) opens the valve and maintains a minimum converter-in oil pressure of 20.5 psi. Thus, oil is allowed to recirculate to the converter from the cooler and is referred to as an "autoflow" oil circuit.

3-66

Press A 67

67

If the converter-in pressure reads 20 psi, we know that _____.

A. the converter pressure relief valve is dumping oil to sump 68
B. the converter-in check valve is open 70
C. the converter pressure regulator is dumping oil to sump 69

3-67

68

No. Look at Figure 1 once more. If the converter pressure relief valve is open, we know that the converter-in pressure has exceeded 80 psi.

Try this question again. 67 Press A

3-68

69

No. If the converter pressure regulator is dumping oil to sump, we know that the converter-out pressure is above 22.5 psi. We are concerned with the converter-in pressure in this question.

Try this question again. 67 Press A

3-69

70

Correct. If the converter-in check valve is open, the converter-in pressure has dropped below 20.5 psi.

Neutral Signal Trimmer Valve (See Figure 1 in AM 2-9). This valve assembly consists of the trimmer valve, valve plug and springs, located in a common bore. Its purpose is to reduce hydraulic oil pressure for a predetermined length of time. The neutral trimmer valve reduces main oil pressure momentarily, when shifting from neutral range to low or reverse ranges, insuring a smooth and positive clutch engagement.

Press A 71

3-70

71

Main oil pressure is present at the trimmer valve in all ranges. Neutral signal oil pressure is present at the valve plug in neutral range only. Therefore, when a shift is made from neutral range, neutral signal oil pressure is exhausted, allowing main pressure to move the trimmer valve and exhaust to sump. Thus, main oil pressure is reduced for range clutch application.

Press A 72

3-71

72

At the same time that main oil pressure is escaping to sump, it also flows through an orifice in the trimmer valve to the area between the valve and valve plug. The trimmer valve is now hydraulically stable. However, the trimmer springs then move the trimmer valve back, closing the exhaust port, allowing main oil pressure to return to the maximum pressure. This valve also functions in this manner when shifting to the other drive ranges.

If you would like to read the last two frames on the trimmer valve again, Press A. If not Press B.

70 73

3-72

73

Neutral signal oil pressure is exhausted from the valve plug when _____.

A. a shift is made from between ranges 74

B. a shift is made from neutral to any range 74

C. Neither A or B is correct. 75

3-73

74

No. Neutral signal oil pressure is exhausted from the trimmer valve plug only when a shift is made from neutral.

Press A 75

3-74

75

OK. When neutral signal oil pressure is exhausted, a gap in the bore is filled with main oil pressure, causing the trimmer valve to move. When the trimmer valve is moved, main oil pressure is directed to sump. This reduces main oil pressure. This situation does not continue because _____.

A. the orifice (allowing main pressure to escape to sump) is too small to handle all the volume 76

B. main oil pressure while flowing to sump also flows through an orifice in the valve 77

C. Neither A or B is correct. 76

3-75

76

No. The correct answer is that main oil pressure while flowing to sump, also flows through an orifice in the valve.

Press A 77

3-76

77

OK. The flow of oil through the valve orifice eventually builds up pressure on the other side of the valve. When the two pressures are equal, the trimmer valve becomes hydraulically stable. When the valve is in this state, the main oil pressure is still dumping into sump. This is a _____ statement.

A. true 79
B. false 78
C. I don't know. 78

3-77

78

No. If you chose false, you are incorrect. When the valve is hydraulically stable it has equal pressures on each side. Under these conditions, main oil pressure still is being dumped into sump.

Press A 79

3-78

79

OK. The main oil pressure would continue dumping to sump if there were no springs on the other end of the valve. These springs move the valve plug back when it becomes hydraulically stable. Hence, the port is closed, main pressure is built up once again, and full pressure is now activating the desired clutch pack.

The purpose of this trimmer valve and the trimmer valve discussed earlier (intermediate range trimmer valve) is to _____.

A. protect wear of the clutch packs 80
B. help build up maximum pressure 80
C. Neither A or B is correct. 81

3-79

80

No. Protecting wear of the clutch packs, or helping to build up maximum pressure, is not the purpose of these valves. Both these valves serve to cushion the effect of full main pressure being applied to the clutch packs all at once.

Press A 81

3-80

81

OK. These valves prevent jerking of the vehicle when shift changes are made, by momentarily delaying full main pressure to the clutch packs.

Congratulations, you have completed the first film on the hydraulic circuit of the 5960 and 6060 Allison transmission. The next film will discuss what occurs when various shift changes are made.

Press REWIND

X(c)-82

3-81

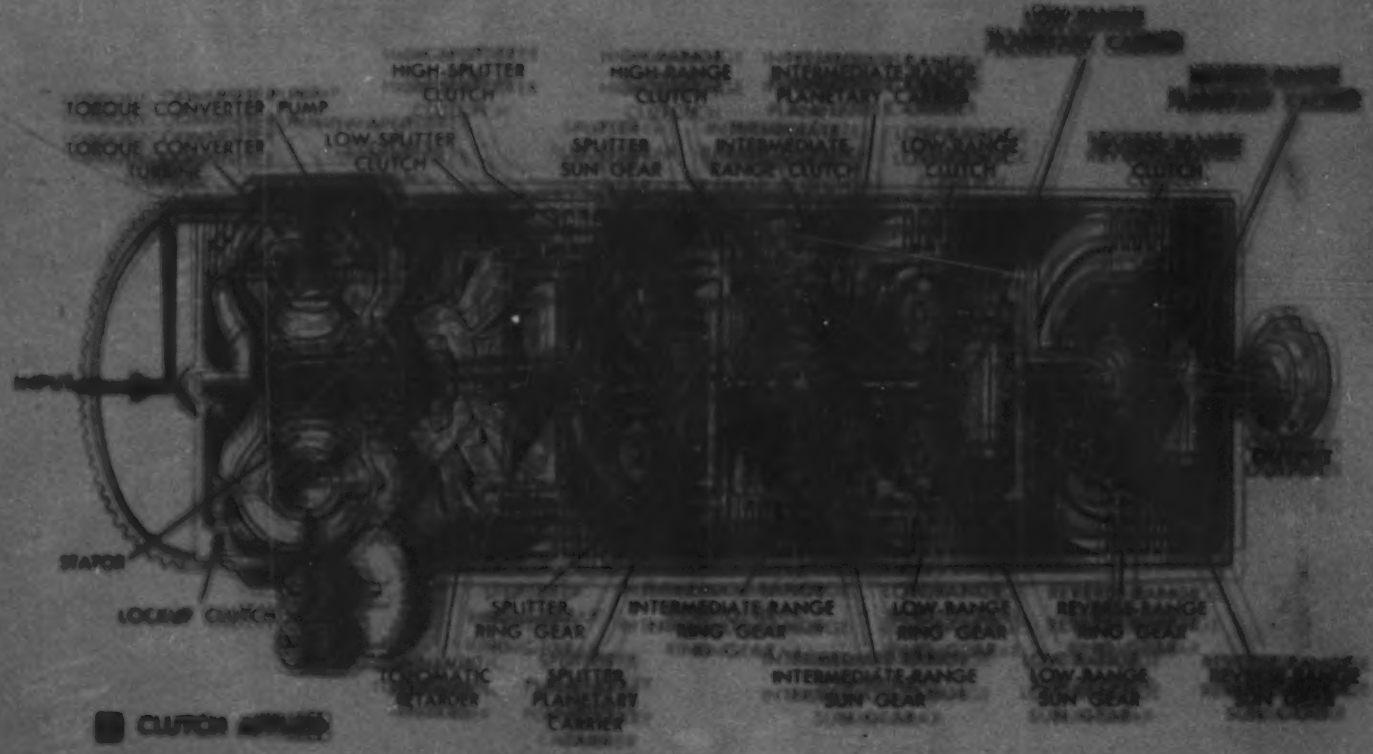
82

The correct answer to the last question is: these valves momentarily delay full main oil pressure from activating the clutch packs.

You have missed one or more of the questions in this sequence. Let's review the last few frames.

Press A 55

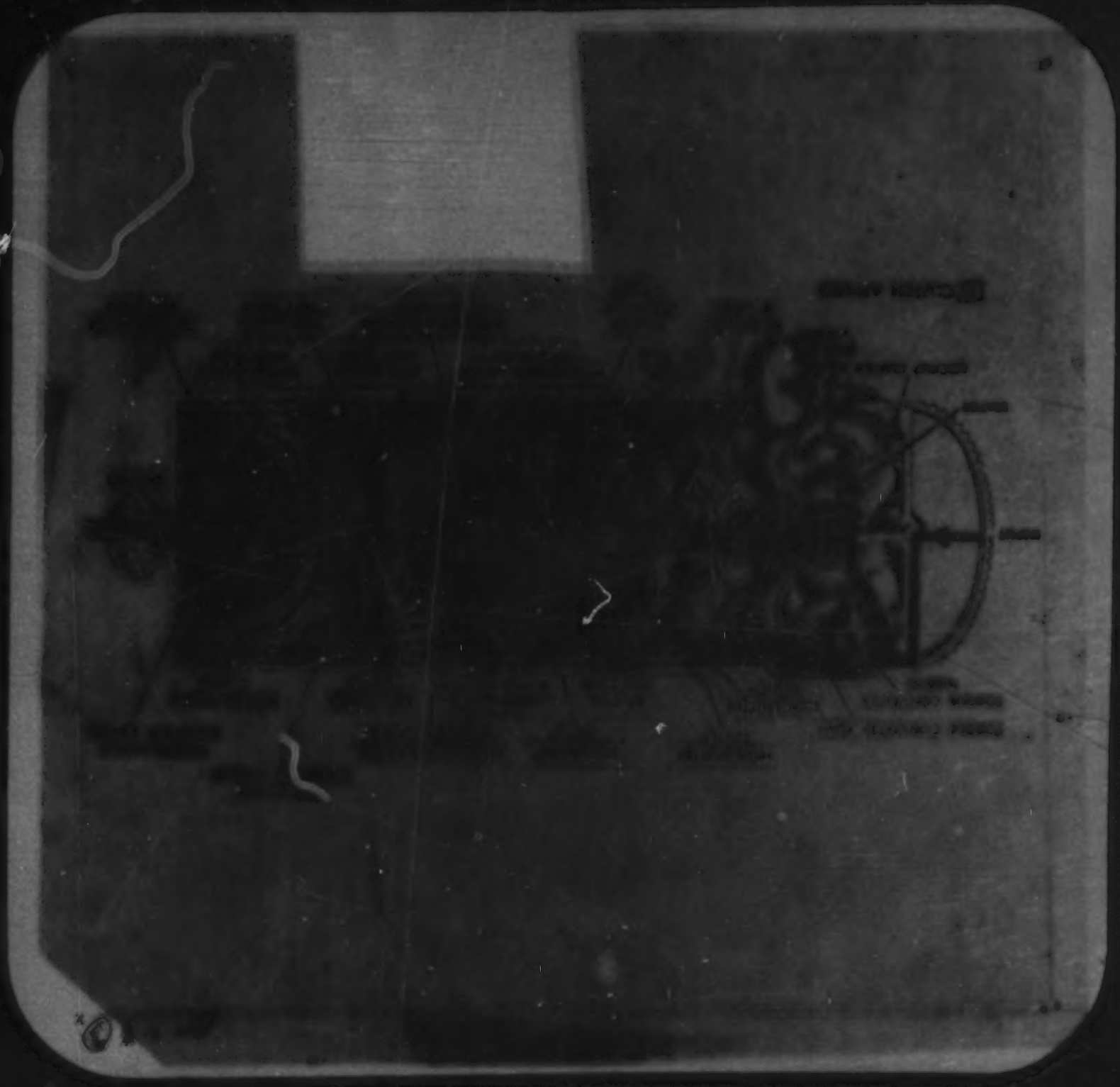
3-82

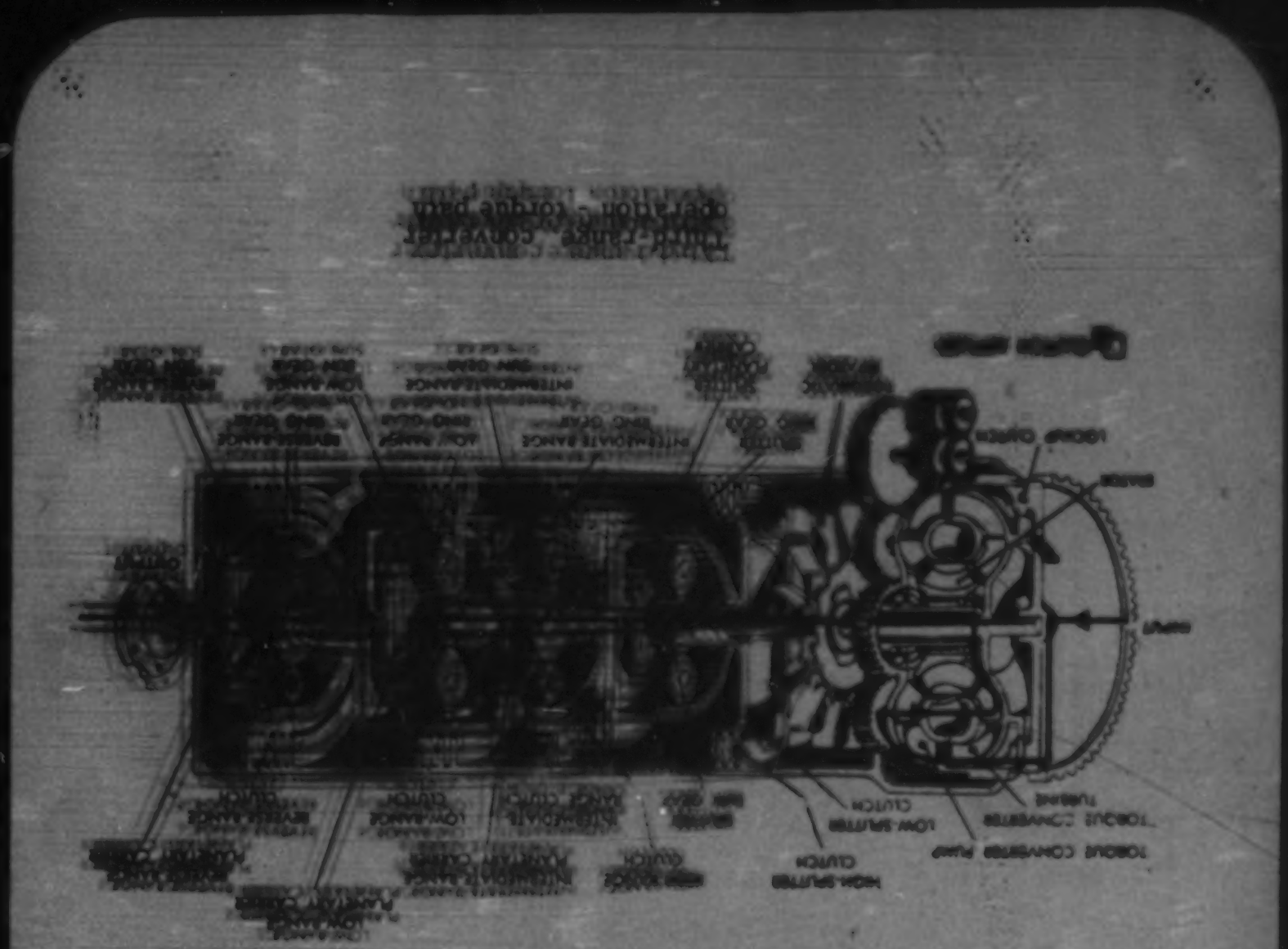


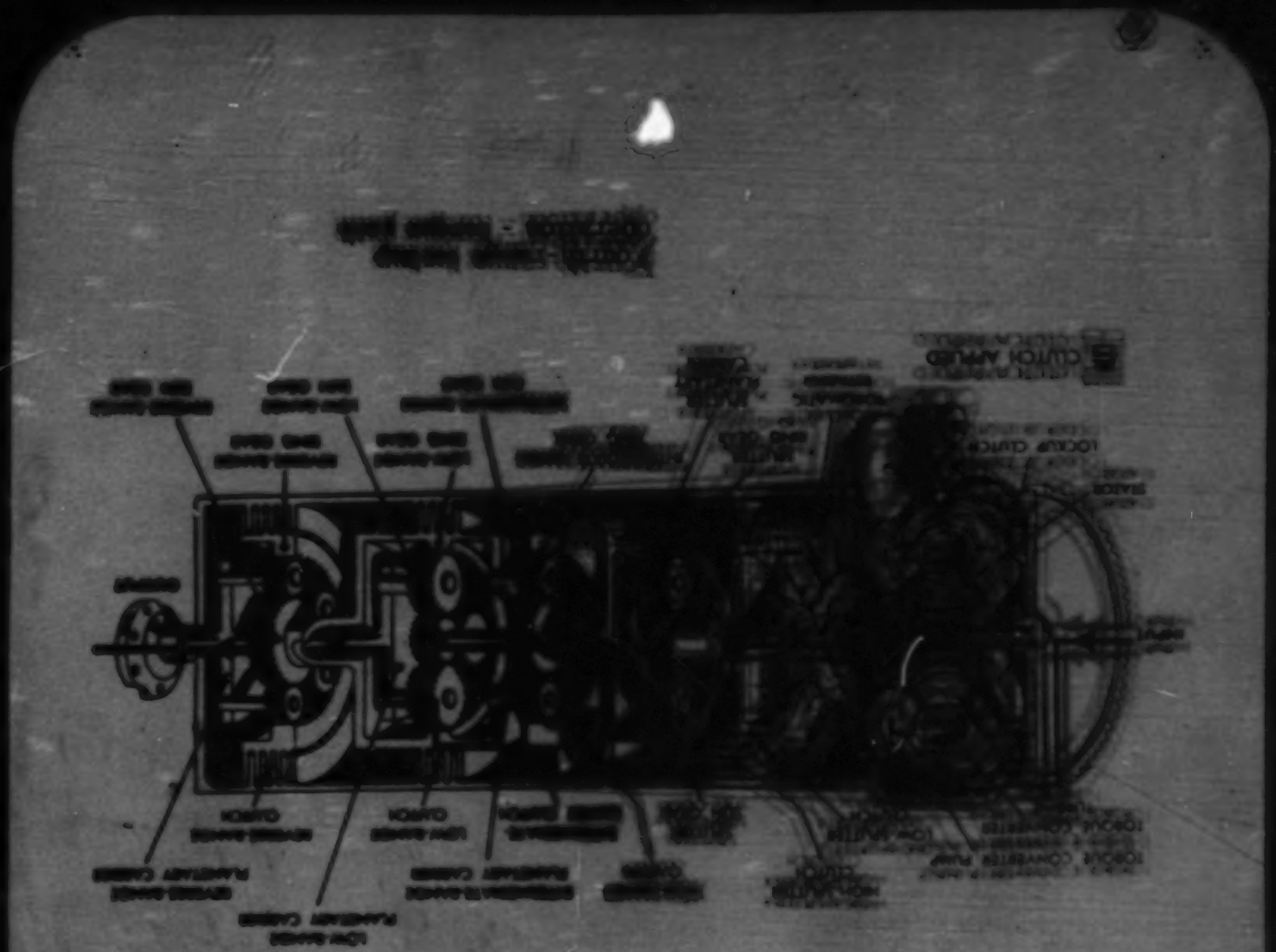
Neutral-range converter operation - torque path

HUMAN ENGINEERING INSTITUTE
2341 Carnegie Ave
Cleveland, Ohio 44115

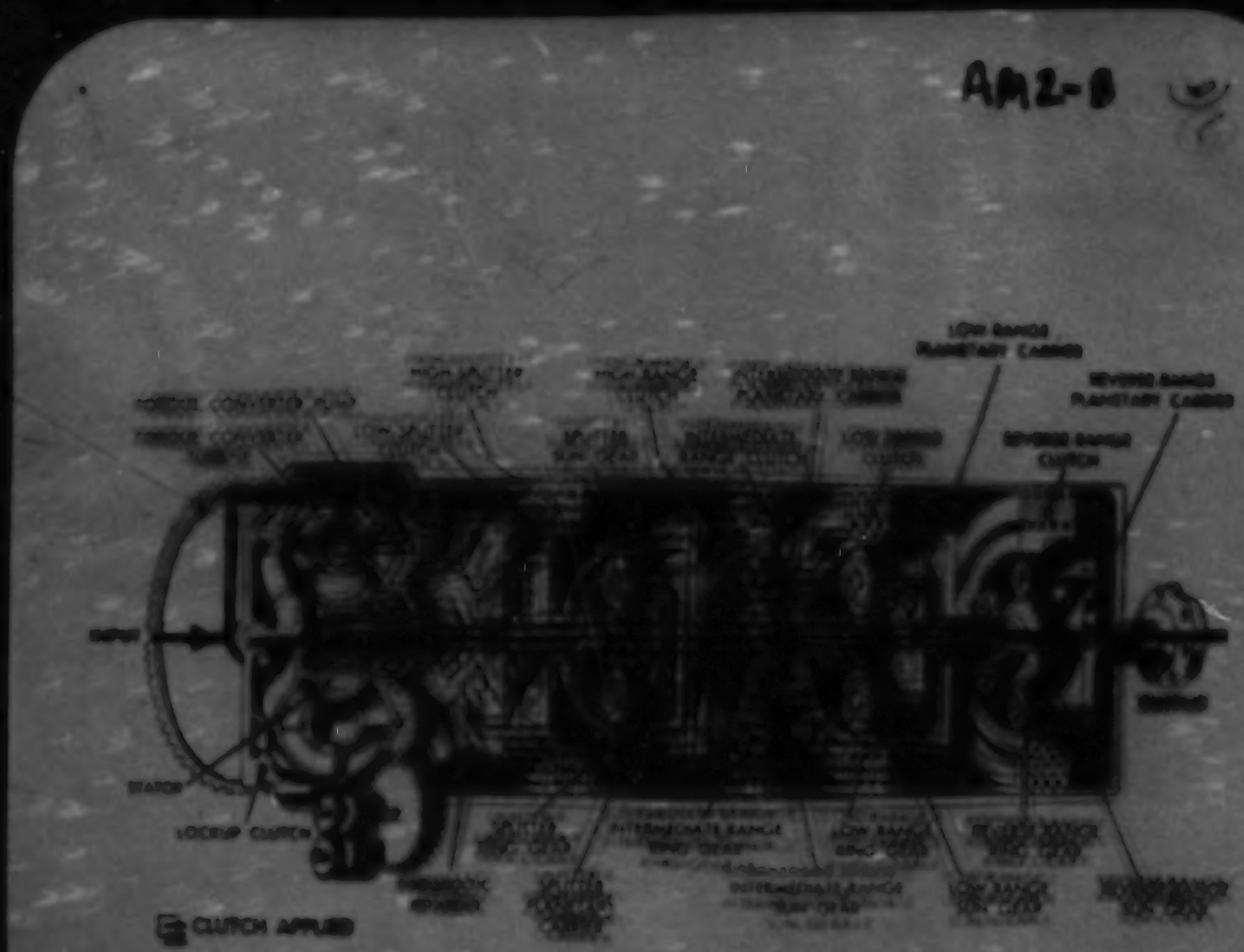
HUMAN ENGINEERING INSTITUTE
[illegible] Carnegie Ave
Cleveland, Ohio 44115



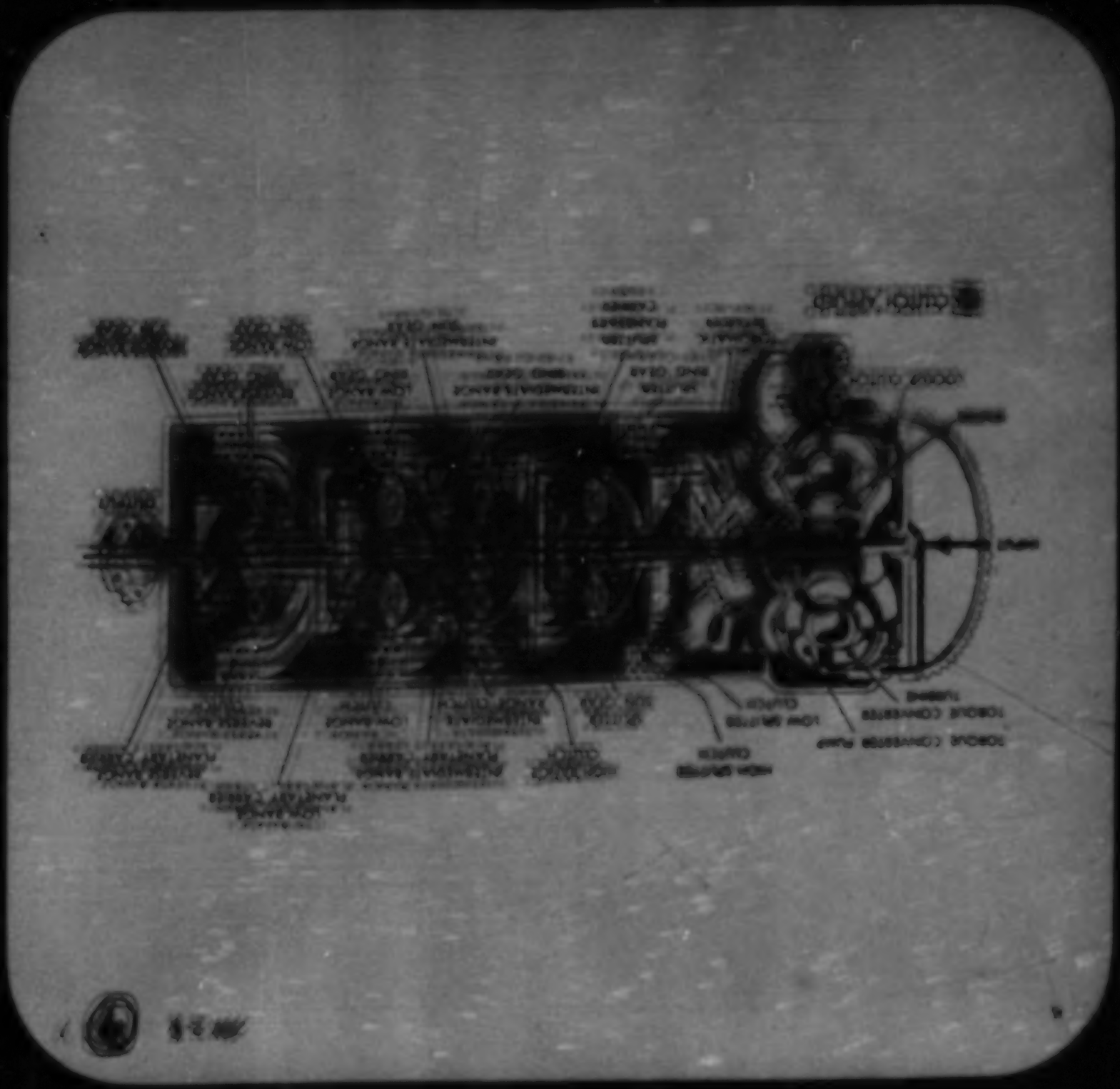




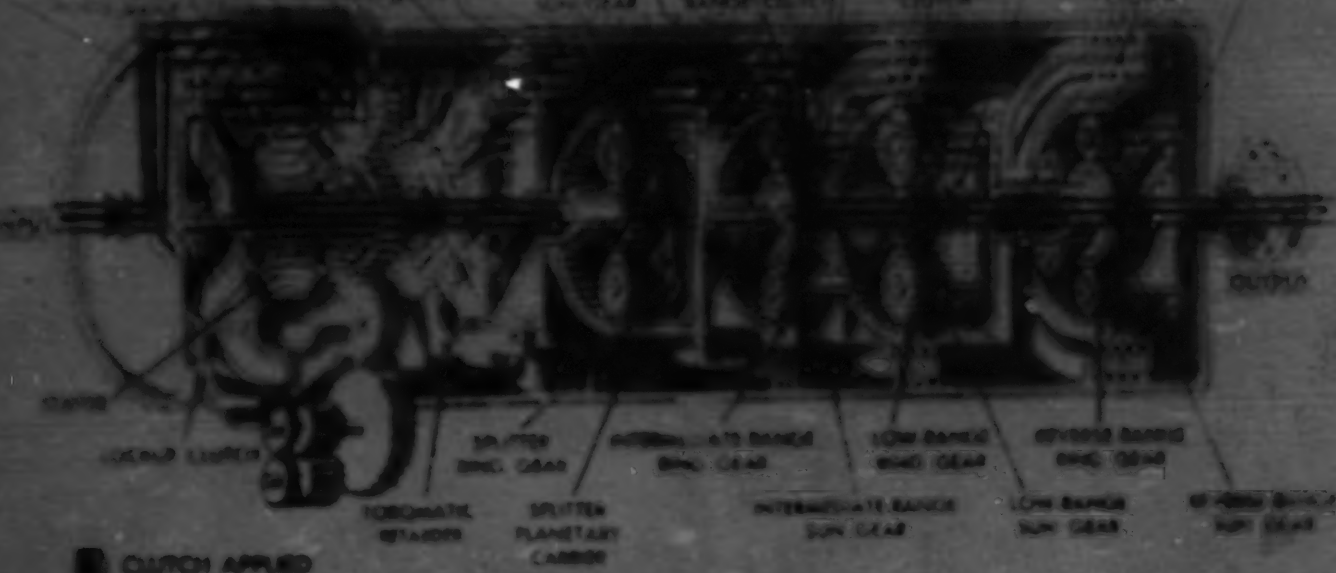
AM2-B



Path - power converter
operation - torque path

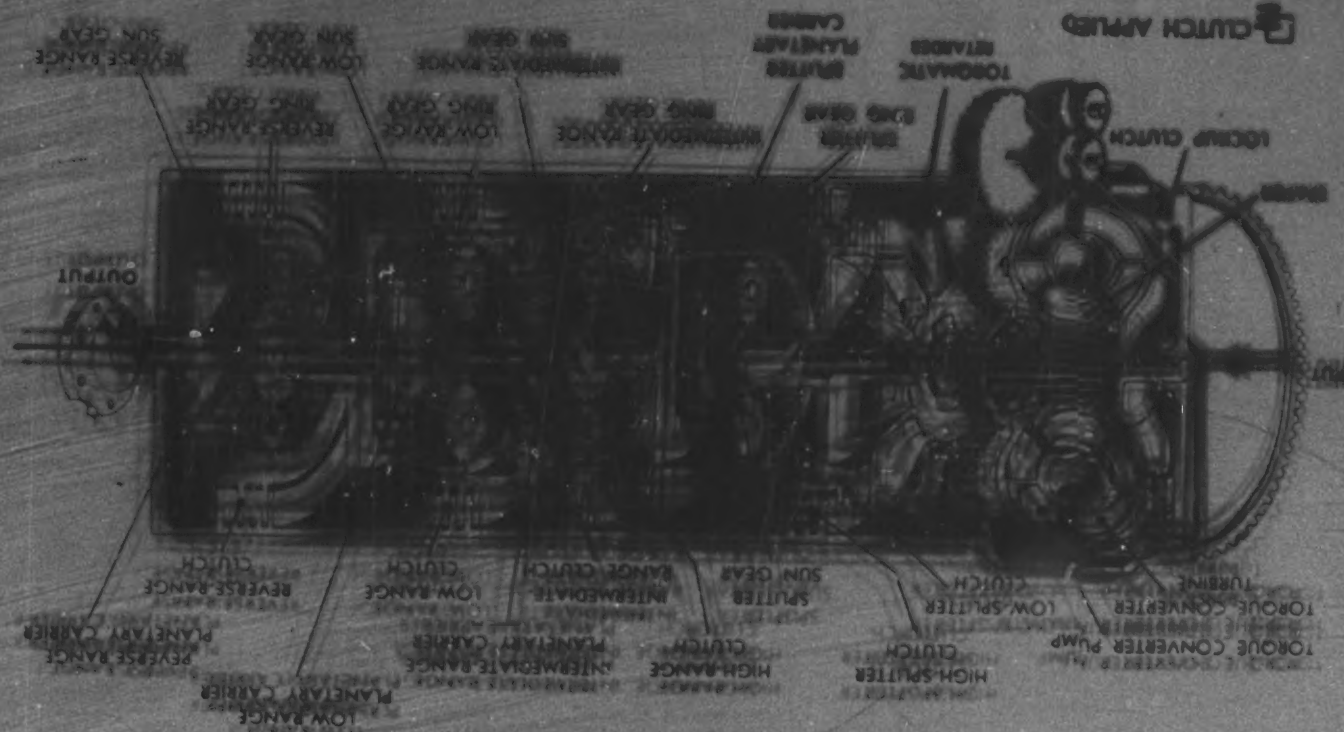


AM 2-8



Sixth-range, converter operation - torque path

Sixth-range, lockup operation - torque path



AM 2-8

Reverse-range converter operation - torque path

AM 2-8
Guide Supplement
6/13/67

INSTRUCTOR'S GUIDE SUPPLEMENT

NOTE TO INSTRUCTOR:

In Unit AM 2-9, Figure 1 is a color foldout of the Allison Torqmatic Hydraulic System.

Films AM 2-8D and AM 2-9D both use this foldout as reference material.

These films CANNOT be used without the color foldout chart.

BE SURE to distribute Unit AM 2-9 simultaneously with AM 2-8D film.

ATTACH THIS SUPPLEMENT to the front of each copy of Instructor's Guide for AM 2-8.

INSTRUCTOR'S GUIDE

Title of Unit: AUTOMATIC TRANSMISSIONS - ALLISON TORQMATIC SERIES 5960, 6060 & 8860 (PART II)

AM 2-8
5/10/67

OBJECTIVES:

1. To cover each component of the transmission, it's function, proper name and it's place in the transmission housing.
2. To explain and show the power flow through the transmission at each range.
3. To give the student some inspection and maintenance tips.
4. To present a troubleshooting chart broken down into TROUBLE/CAUSE/CHECK and/or REMEDY.

LEARNING AIDS suggested:

VU CELLS:

AM 2-8 (1) Neutral-range, converter operation-torque path
AM 2-8 (2) First range, converter operation-torque path
AM 2-8 (3) Second-range, lockup operation-torque path
AM 2-8 (4) Third-range, converter operation-torque path
AM 2-8 (5) Fourth-range, lockup operation-torque path
AM 2-8 (6) Fifth-range, converter operation-torque path
AM 2-8 (7) Fifth-range, lockup operation-torque path
AM 2-8 (8) Sixth-range, converter operation-torque path
AM 2-8 (9) Sixth-range, lockup operation-torque path
AM 2-8 (10) Reverse-range, converter operation-torque path

NOTE TO INSTRUCTOR:

There should be Allison Wall Charts, training films, slides, etc. at your center. If not, contact your local Allison Distributor for these and other aids he may have available for use.

QUESTIONS FOR DISCUSSION AND GROUP PARTICIPATION:

1. Are there two different gearing sections in the transmission being discussed?

2. How are the friction clutches applied? How are they released? When are they released?

3. How many clutch packs have to be activated before the transmission will move the vehicle?

4. In what positions is the splitter low clutch pack activated?

5. When is the splitter high clutch pack activated?

6. Why doesn't the vehicle move when the transmission is in the NEUTRAL position?

7. How is the vehicle able to go in a REVERSE direction ?

8. What should be done if the converter temperature rises above 250 F ?

9. Why would clutch pressure be critical in the NEUTRAL position ?

10. What are some of the troubles that could occur with the transmission?